U. S. DEPARTMENT OF AGRICULTURE.

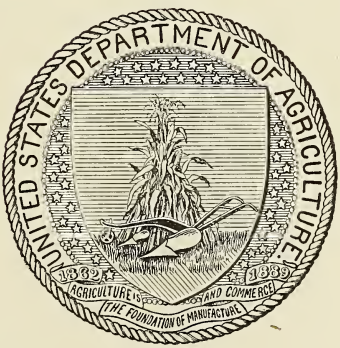
FARMERS' BULLETIN No. 189.

INFORMATION CONCERNING THE MEXICAN COTTON BOLL WEEVIL.

BY

W. D. HUNTER,

Special Agent in Charge of Cotton Boll Weevil Investigations, Division of Entomology.



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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Division of Entomology,
Washington, D. C., January 11, 1904.

Sir: I have the honor to transmit herewith an article entitled "Information Concerning the Mexican Cotton Boll Weevil," by Mr. W. D. Hunter, special agent of the Division of Entomology in charge of the cotton boll weevil investigations. Owing to the great importance of the subject and the urgent demand for all possible information before planting, I urge its immediate publication as a farmers' bulletin.

Respectfully,

L. O. Howard,
Entomologist.

Hon. James Wilson,
Secretary of Agriculture.

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INFORMATION CONCERNING THE MEXICAN COTTON BOLL WEEVIL.

RECOMMENDATIONS.

The work of the Division of Entomology for several years has demonstrated that there is not even a remote probability that the boll weevil will ever be exterminated. Although the very large yields of cotton of former times may no longer be possible, it is nevertheless entirely feasible to produce cotton at a margin of profit that will compare favorably with that involved in the production of most of the staple crops of the United States by following what have become known generally as the cultural methods. These methods consist of the following changes and modifications of the system of cotton raising made necessary by the weevil. They were originally suggested by a careful study of the life history and habits of the pest, and naturally any improvements that may eventually be made will be the result of the continuation of that study. They have now been tested successfully on a large scale by the Division of Entomology, as well as by many planters, during two very unfavorable seasons. Of greatest advantage is the reducing of the numbers of the weevils by the destruction of the plants in the fall. The advantage thus gained is followed up by bending every effort toward procuring an early crop the following season.

(1) Plant early. If possible plant seed of the varieties known to mature early, or at least obtain seed from as far north as possible. It is much better to run the risk of replanting, which is not an expensive operation, than to have the crop delayed. The practice of some planters of making two plantings to avoid having all the work of chopping thrown into a short period is a very bad policy from the weevil standpoint.

Under identical conditions early cotton of improved varieties has invariably yielded from two to three times as much as native cotton under the same conditions, and in many cases much more. Planted at the same time, the early varieties begin to bloom from twelve to eighteen days sooner than native cotton.

Early planted fields of either native or improved varieties have almost invariably yielded twice as much as late planted ones.

The early varieties in general, having a small stalk and a short taproot, are adapted only for rich soil. They also fail to grow well in the

very light, drifting sandy loams of many of the river valleys of Texas which, in long seasons before the advent of the boll weevil, often produced the largest yields. In these situations early varieties will yield but little more than native cotton.

(2) Cultivate the fields thoroughly. The principal benefit in this comes from the influence that such a practice has upon the constant growth and consequent early maturity of the crop. Very few weevils are killed by cultivation. Much of the benefit of early planting is lost unless it is followed by thorough cultivation. In case of unavoidably delayed planting, the best course for the planter to pursue is to cultivate the fields in the most thorough manner possible. Three choppings and five plowings constitute as thorough a system of cultivation as is necessary in cases where the land has previously been kept reasonably clear.

(3) Plant the rows as far apart as experience with the land indicates is feasible, and thin out the plants in the rows thoroughly. On land which in normal seasons will produce from 35 to 40 bushels of corn the rows should be 5 feet apart. Even on poor soil it is doubtful if the distance should ever be less than 4 feet.

(4) Destroy, by plowing up, windrowing, and burning, all the cotton stalks in the fields as soon as the weevils become so numerous that practically all the fruit is being punctured. This will generally not be later than the first week in October. Merely cutting off the stalks by means of the triangular implement used for that purpose throughout the South is by no means as effective as plowing, because the stumps remaining give rise to sprouts which furnish food until late in the season to many weevils that would otherwise starve. The plowing, moreover, serves to place the ground in better condition for early planting the following spring. In some cases turning cattle into the fields is advisable. Aside from amounting to a practical destruction of the plants, grazing of the cotton fields furnishes considerable forage at a time when it is generally much in demand. Nevertheless, cattle should never be turned into cotton fields in which Johnson grass has become started.

Recommendations 1, 2, and 3 are all aimed toward avoiding damage by hastening the maturity of the plants and do not involve the actual destruction of the weevils. Recommendation 4, however, reduces the numbers of the pests by destroying the very great proportion developing late in the fall and is consequently directly remedial.

(5) It is known that at present fertilizers are not used to any considerable extent in cotton producing in Texas. There is, nevertheless, no doubt that they should be; not that the land is poor, but that earlier crops may be procured. At present it is sufficient to call attention to the fact that it has been the uniform experience of experiment stations and planters in the eastern part of the belt that certain fertilizers, especially those involving a large percentage of phosphoric acid, have a strong tendency towards hastening the maturity of the plants.

INTRODUCTORY.

It is not probable that there will ever be a more generally unfavorable year for cotton culture in the United States than that of 1903. Toward the close of the preceding year (1902) the Bureau of Statistics of the United States Department of Agriculture reported a condition of the cotton crop, resulting from insect ravages and unfavorable climatic conditions in Texas, little short of disastrous. But the season of 1903 has had as many unfavorable features, and in addition the drawback that planting was unavoidably uniformly thrown from four to six weeks late. This was especially unfortunate, as early planting is the most important step in avoiding damage by the weevil. Many planters were unable to put in one-half of their normal cotton acreage. The late planting season was followed by very irregular rains. As a rule severe droughts alternated with heavy rains. The result would have been to cause a small crop regardless of damage by the boll weevil, and this was especially noticeable in central Texas. The experience of Mr. Harry Fields, a prominent planter of Robertson County, is typical of that of a great many planters in that part of the State. In 1902 on a certain cut of 180 acres 65 bales of cotton were produced. On the same land in 1903 only 15 bales were produced. These unfavorable conditions necessarily handicapped the work of the Division of Entomology, and in the experimental fields some points that would doubtless be perfectly evident under normal conditions were but little apparent; for instance, in many fields wide spacing of the rows was rendered fruitless, and some fields were so late that additional cultivation did not have the effect that it should. Nevertheless, the Division succeeded in proving by several striking illustrations that cotton may still be produced in Texas, and in not one of the experimental fields, aggregating 558 acres, did the crop fall much below the average in the United States before the weevil came into Texas—that is, about one-half bale to the acre—except in a few cases where there was a poor stand or the crop was damaged by floods. It should be understood, however, that this yield of about half a bale to the acre does not apply to the check fields, which were necessary in order to determine the results of the experiments. Even in the one case where the Division produced a bale to the acre, the adjoining check fields produced practically nothing. Some of the more noteworthy results of the work of the season that are unmistakable despite the unfavorable conditions have been selected for presentation on the following pages with matter relating to the methods pursued, as well as an account of some other matters—such as territory affected, the amount of damage, and the prospects—that are of particular interest at this time.

TERRITORY AFFECTED.

Up to the present time (January, 1904) the boll weevil has been found outside of the State of Texas in only three instances. One of these was at Audubon Park in the vicinity of New Orleans, where one of the fields of the Sugar Experiment Station at that place was found infested in August. The station authorities, under the direction of their entomologist, in a prompt and well-advised manner destroyed all the cotton by picking up the fallen fruit, uprooting and burning the plants, and subsequently flooding and plowing the land after it had been burned over. As there are no other cotton fields within 9 miles of Audubon Park and several examinations of the nearest ones failed to reveal any weevils, it is likely that the colony was completely exterminated. The two localities in Louisiana where the weevil is known to exist at present are in Sabine Parish, directly opposite to Shelby County, Tex. In both these cases only isolated fields are infested, and the circumstances indicate that the pest was brought from Texas in cotton seed or other cotton products. The Louisiana authorities are attempting to exterminate these colonies as they did that at Audubon Park.

The accompanying map shows the territory at present affected by the weevil in Texas and Louisiana (fig. 1).[a] On the north it has been found in the vicinity of Sherman, only a few miles south of the Red River. The nearest approach to Shreveport is in Morris County, about 50 miles away. It should be observed, however, as indicated on the map, that in the region from about the latitude of Dallas to the Red River the pest is only scatteringly present and has caused no general damage. It will require about two years to reach sufficient numbers to reduce the normal production materially.

[a] The map is incorrect in regard to the exact location of the infested region in Louisiana. The shaded portion should include the western edge of Sabine instead of De Soto Parish.

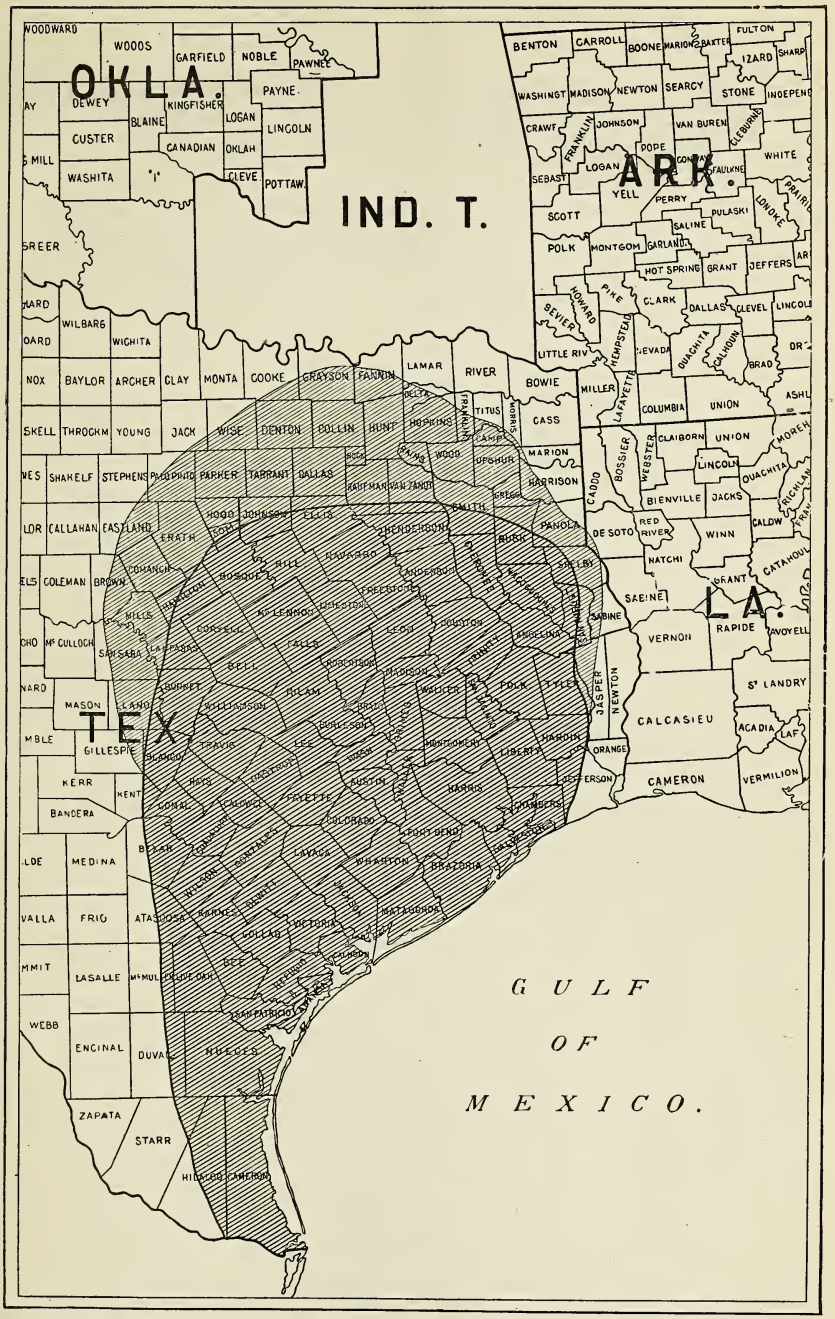

FIG. 1.—Map showing distribution of cotton boll weevil in the United States. The heavy line indicates the limit of the region in which the weevils have multiplied to such an extent as to be found in all cotton fields; the remainder of the shaded portion indicates the region in which isolated colonies are known to exist (original). See correction in footnote on opposite page.

AMOUNT OF DAMAGE.

Although many conditions make it very difficult to reduce the damage caused by the weevil to figures, it is believed that the following table presents a reasonably accurate estimate of the extent to which the pest affects the production of cotton for a few years subsequent to its advent:

Comparative estimate of amount of damage by cotton-boll weevil.

Typical counties in which weevil was not present in 1899, but was present in 1902.			Typical counties in which weevil was not present in either 1899 or 1902.		
County.	Product in commercial bales.		County.	Product in commercial bales.	
	1899.	1902.		1899.	1902.
Caldwell	47,473	23,133	Montague	15,064	16,981
Colorado	30,923	11,493	Cooke	11,905	11,012
Fayette	73,238	31,200	Grayson	40,871	54,087
Gonzales	44,131	25,351	Fannin	59,802	70,540
Grimes	26,541	12,135	Lamar	49,193	59,269
Lavaca	42,484	22,906	Wise	17,556	18,869
Montgomery	10,272	3,660	Denton	20,381	24,541
San Jacinto	8,826	3,044	Collin	49,077	47,344
Travis	60,078	28,382	Hunt	50,317	49,713
Wharton	27,383	12,870	Delta	24,705	26,256
Total	371,349	174,174	Total	338,871	378,612
Decrease.....per cent		53	Increase.....per cent		11

The first section of the above table shows a comparison of the production in ten counties in Texas in 1899, when the weevil had scarcely reached them, and in 1902, when it had multiplied to such an extent as to be found in great numbers in practically all cotton fields. These two years were selected for comparison for the reason that they were practically identical in amount and distribution of rainfall and in other essential crop conditions. The second part of the table gives a comparison of the production during the same years in ten other leading counties situated so far north that the weevil had not affected them in either of the two years used for comparison. It will be noticed that while in the counties of the first series there had been a decrease in production of 53 per cent, in the counties of the second series there had been an increase of 11 per cent. There seems to be no reason why the cotton production of the counties of the first series would not have increased at about the same rate as was the case in those of the second series had it not been for the damage caused by the weevil. This makes it fair, it is believed, to conclude that the approximate damage caused by the insect was the sum of the decrease in one case and the increase in the other, or about 64 per cent. There are two sources of possible error in these figures. One is in the likelihood of a change in acreage between 1899 and 1902 that may not have affected the two regions alike, and the other is in the probability that the two seasons were not exactly similar. In relation to the first point it must be stated that increases in acreage are generally the result of conditions of the markets that would affect the whole State

alike, and that if there were any increase in these years it would probably have been very much alike in either case. As to the possibility of an appreciable difference in the seasons, it must be stated that the two regions are comparatively close together, and that a careful examination of the records shows that they were remarkably alike in all important respects. Nevertheless, it is the tendency of planters, as soon as the weevil becomes a serious menace, to devote more of their land to other crops. Accurate figures on this point are not obtainable, but on the whole an allowance of a reduction of this kind that would account for 10 per cent decrease in production would be ample. It therefore seems to the writer that a figure in the neighborhood of 50 per cent represents a very fair approximate estimate of the loss.

In this connection it is interesting to note that the statistics drawn from acreage and production to which the writer referred in a previous article (Yearbook, Department of Agriculture, 1901, p. 373), indicating that the boll weevil causes the amount of land required to produce a bale to be practically doubled, bear out the foregoing conclusions.

Upon the foregoing basis, during the past season the boll weevil has caused the planters of the State of Texas a loss of fully $15,000,000, and this estimate agrees rather well with the estimates made in other ways by the more conservative cotton statisticians.

Many conditions of climate and plantation practice in the eastern portion of the cotton belt indicate that the weevil problem will eventually be as serious there as it now is in Texas. With Mr. Richard H. Edmunds's estimate that the normal cotton crop of the United States represents a value of $500,000,000, the possible ultimate damage when the pest has spread over the belt would be in the neighborhood of $250,000,000 annually, provided no means of avoiding damage were adopted.

There are conditions at work that seem to indicate that planters in the weevil region are gradually adopting changes in their system of producing the staple that have a tendency to avert damage. No one who travels through the southern counties of Texas or who carefully examines the statistics pertaining to that region can avoid the conclusion that the planters will continue to produce cotton profitably and with a comparatively immaterial decrease. For instance, the following table shows to what extent cotton has been raised in Victoria County since the weevil reached it:

Cotton production in Victoria County, Tex., in equivalents of 500-pound bales.

Year.	Bales.	Year.	Bales.
1894	6,895	1899	5,547
1895	4,404	1900	11,956
1896	9,796	1901	9,060
1897	7,748	1902	9,236
1898	7,006		

PLAN OF THE INVESTIGATIONS OF THE DIVISION OF ENTOMOLOGY.

The work of the Division of Entomology consists of field experiments and laboratory investigations. Four entomologists were engaged in the work in Texas, and one conducted studies in Cuba. The field work of the season of 1903 comprised considerable tracts of cotton grown in such a manner as to constitute demonstrations of the means necessary to produce the staple profitably in spite of the weevil. These experimental fields amounted to 558 acres located at seven different points representing the five regions in Texas which by reasons of variations in climate and soil constitute as many distinct cotton districts. One hundred and fifty-six acres at Victoria and Wharton together represented typical situations in the river valleys of the coast belt, where the occurrence of volunteer cotton is rather normal, and by furnishing early food for the pests in the spring involves a feature that is lacking elsewhere. Twelve acres at San Antonio represented the problem in the case of cotton grown under irrigation, where the work of the season has shown that it is particularly easy to control the pest. At Austin 100 acres were devoted to experiments in the typical high black prairie region, which includes the most productive counties in Texas. At Calvert, in the Brazos River Valley, 200 acres, the largest body of experimental cotton at one place, represented the river valley region of central Texas, where the low and moist situation, presence of timber, defective labor system, and almost exclusive production of cotton together make what will be the most serious weevil region in the United States until the Yazoo Valley in Mississippi shall become invaded. At Hetty and Willspoint 40 and 50 acres, respectively, represented the river valley region of north Texas and the high prairie country of that portion of the State. Under a contract representative planters at the several places undertook to prepare the land, plant and care for the crop in every detail exactly in accordance with the directions of the Division of Entomology. The system gives the Division practically complete charge of large tracts of cotton without involving the expense of renting the land and working the crop, and has been found to be a most satisfactory method of conducting such field work on a large scale. In these fields every expedient that has been found to be useful in avoiding damage by the weevil was tried. These include early varieties, different methods of planting, special cultivation, rotation, fall destruction of the plants in various ways, and many others. The most difficult feature in work of this kind is in the interpretation of the results and in attributing to each factor in the process the effect that belongs to it. To assist as much as possible in this matter, wherever a field was treated in any manner out of the ordinary, another one alongside of it, as a check, was given only the

ordinary attention. The accompanying plan (fig. 2) will illustrate the method of one of these experiments located near Austin upon the plantation of Mr. Jefferson Johnson. The field contained 100 acres and was divided into 16 blocks containing 6¼ acres each, separated by rows of Milo maize to avoid confusion in picking.

It will be seen that a typical early variety, the King, is contrasted with the ordinary cotton of the region. Each one of the plats of the King cotton serves as a check upon each of the plats of that variety as well as upon a plat of the same size of native cotton treated in exactly the same manner. It thus becomes possible to estimate with reasonable accuracy the effect of select seed, early planting, wide rows, and thorough cultivation.

The work of the Division of Entomology during the season of 1902 demonstrated that it is possible to produce cotton profitably in spite of the boll weevil; the work of the season of 1903 showed this again under different conditions of climate and soil on a larger scale, and in addition furnished practical demonstrations of the success of the recommendations of the Division to planters at six different points in the State. For example, in a 25-acre experimental field located at Wharton a bale to the acre was picked. This experiment was performed upon land that had been in cotton continuously for five years, and the weevil had been present in the neighborhood for eight years. As the average crop of cotton in the United States has been 1 bale to 2.3 acres, and as the average production the present year in Wharton County was probably in the neighborhood of 1 bale to 7 or 8 acres, this experiment was naturally of considerable importance as a demonstration to the people of that region.

As will always be the case in formulating a plan for avoiding damage by an insect, the basis for what are now known as the cultural methods of combating the boll weevil was the result of careful studies of its life history and habits. In the hope of discovering points hitherto unnoticed that might be of use in fighting the pest, the investigation of every feature of the life history of the weevil was continued in the laboratory at Victoria. The observations and experiments made here during the season of 1903, as well as the season of 1902, will result in the publication in the near future of an account of the biology of the weevil at least as complete, it is believed, as that of any North American species. At the same time many tests of poisons and spraying mixtures were made in the laboratory whenever samples of the various compounds that had been widely advertised in Texas could be obtained. As would be supposed, none of these preparations were found to be effective, and reports to that effect made to correspondents doubtless prevented some useless expenditure of money.

The cooperation with the commission of the Mexican Government

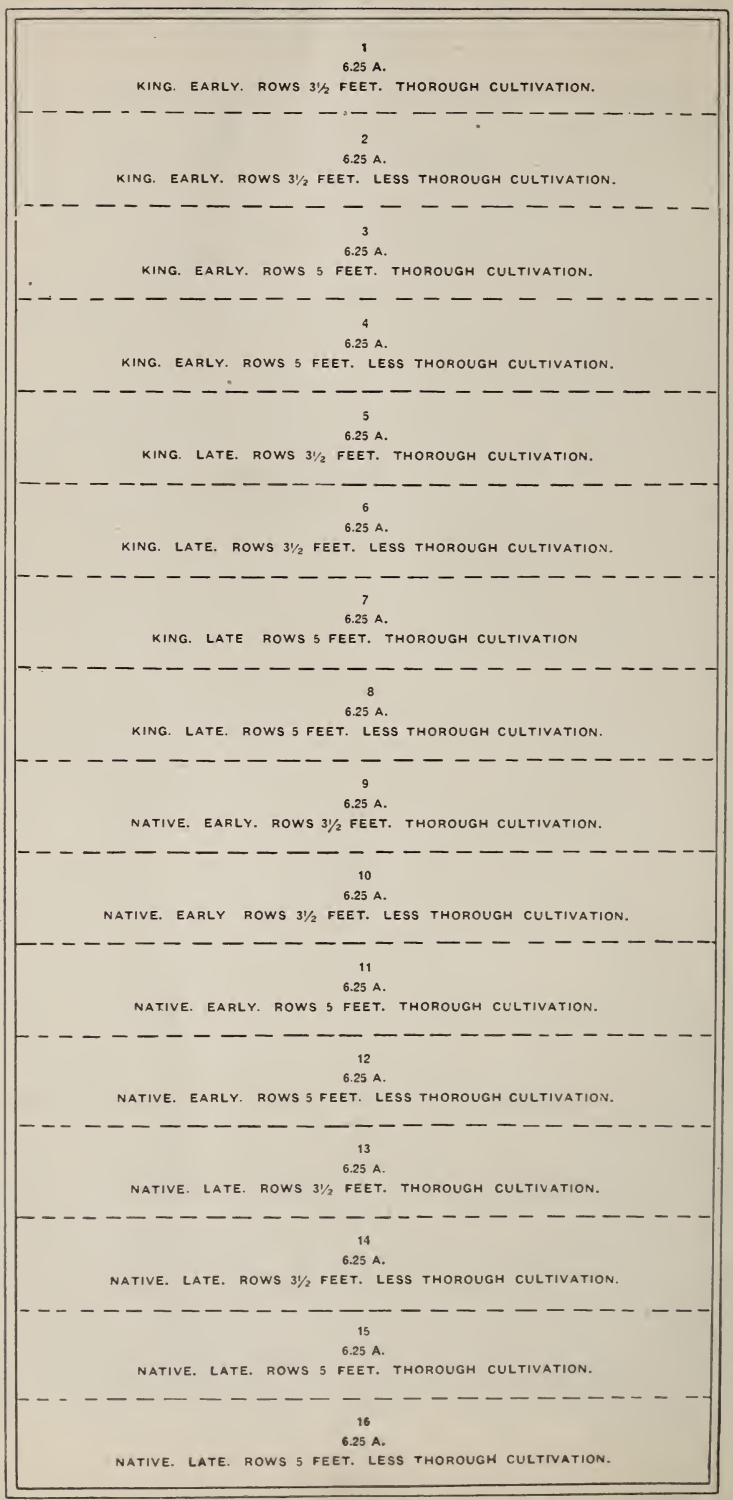

FIG. 2.—Plan of experimental field, Travis County, plantation of Mr. Jefferson Johnson.

engaged in an investigation of the weevil in that country, which was begun the preceding year, was continued. Much material, such as parasites, was exchanged, and each investigation was kept informed of the progress of the other.

In addition to the work in Texas Mr. E. A. Schwarz spent several months of the past year in Cuba, studying the manner in which natural conditions, whether of parasites, diseases, climatic conditions, or of the presence of a degree of resistance on the part of the plant, controlled the insect where it has existed as an enemy of cotton for a much longer period than in the United States. He found what appears to be the original food plant in the "algodon de riñon" or kidney cotton of that island. Nevertheless, he failed to discover any parasites at all, and did not succeed in finding any important tendency toward immunity on the part of the five distinct varieties studied. Through the interest and courtesy of Mr. Edward Ferrer, the proprietor of a large estate nearer Cayamas, Mr. Schwarz arranged to have several wild varieties planted on land where a seriously infested field had grown the year before. Mr. Ferrer has very recently reported that none of these varieties have exhibited the slightest tendency toward immunity, the squares of the native varieties being punctured as freely by the weevils as those of the ordinary American cotton. The experiment thus bears out the previously published conclusions of the investigators of the Division of Entomology, based upon observations in Mexico and Central America as well as in Texas, that apparently no known variety or strain of cotton is distasteful to the weevil. However, the importance of a continuation of this line of the work is evident.

SOME OF THE RESULTS OF THE FIELD WORK.

Upon the plantation of Mr. A. P. Borden, to which reference has already been made, the Division of Entomology had a 100-acre field planted in such a manner as to show the value of several methods of treatment. The experiment was purposely located upon land that had been in cotton for a number of years, and in a situation adjoining the river, where the weevil damage is generally greatest. As will be seen in the accompanying diagram (fig. 3), the field was divided into four plats of 25 acres each. All the plats were planted with the seed of a typical early maturing variety. Two of these plats were planted as early as possible, and one of these was given more thorough cultivation than the other. The two remaining plats were planted late, and the same difference in cultivation applied. The results were as follows:

Early King cotton with thorough cultivation produced 459 pounds of lint to the acre.

Early King cotton with less thorough cultivation produced 250 pounds of lint to the acre.

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Late cotton, regardless of cultivation, produced nothing.

There are two respects in which the results of this experiment would probably have been different under different climatic conditions. In another season there would probably not be as great a difference in yield, due to additional cultivation, and, moreover, there would doubtless be some cotton produced on the other plats in spite of

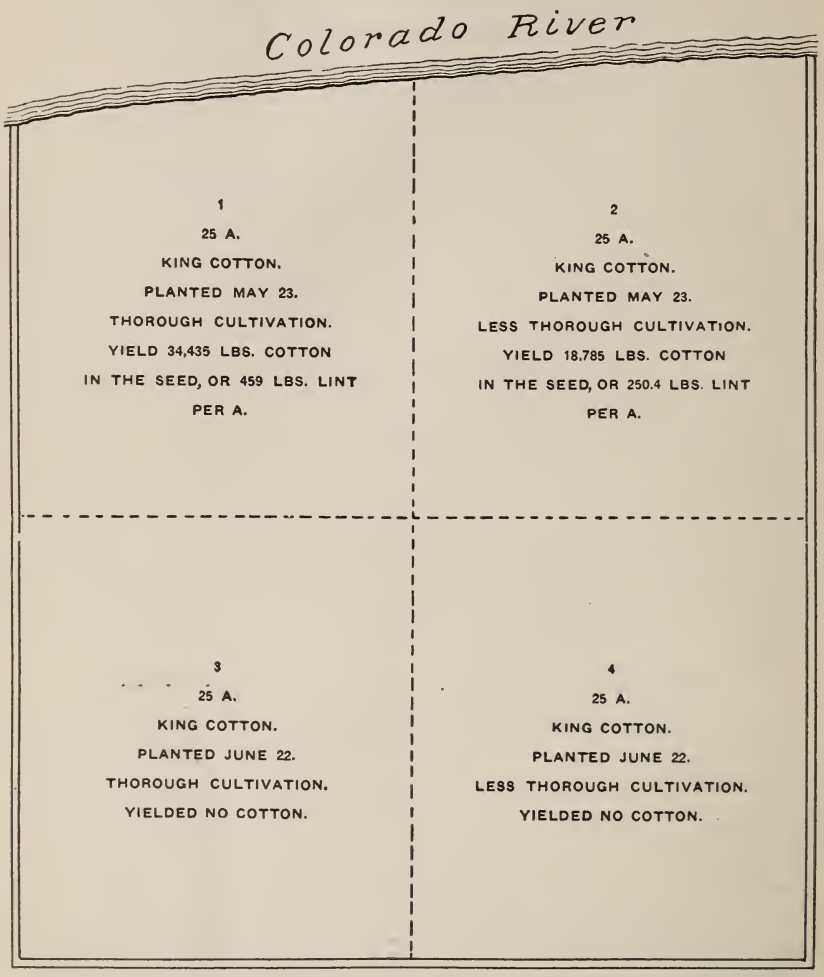

FIG. 3.—Plan of experiment upon plantation of Mr. A. P. Borden, Wharton County, Texas.

the late planting. Nevertheless, experiments at other points show that, with some variation that is always associated with the seasons, the results of this experiment as regards the advantage of early planting and thorough cultivation will apply to practically all situations.

An examination of the profit on the 100 acres covered by this experiment proves to be interesting. The cotton was sold in the seed at $3.25

per 100 pounds. The cost of producing it, including such items as taxes on the land, wear and tear of machinery, and all the other operations, from breaking the land to ginning the product, computed for the lint, was 4¼ cents per pound. There was consequently a margin of profit in plat 1 of $25.24 per acre; on plat 2, of $13.79 per acre, or an average on the 50 acres of early cotton of $19.51 per acre. Reckoning the loss incurred in working plats 3 and 4, which produced nothing, at $6 per acre, there was nevertheless a net margin of profit on the 100 acres of $6.76 per acre. A tabular statement of these results follows:

PLAT I.

Value of yield, 34,435 pounds in seed (11,475 pounds lint), at $3.25 per 100 pounds	$1,119.13
Cost of producing 11,475 pounds lint, at 4¼ cents per pound	487.68
Net profit on 25 acres	631.45
Net profit per acre	25.24

PLAT II.

Value of yield, 18,785 pounds in seed (6,250 pounds lint), at $3.25 per 100 pounds	610.51
Cost of producing 6,250 pounds lint, at 4¼ cents per pound	265.62
Net profit on 25 acres	344.89
Net profit per acre	13.79

100 ACRES COVERED BY EXPERIMENT.

Value of yield, 53,220 pounds in seed, at $3.25 per 100 pounds		1,729.65
Cost:		
Plat I	$487.68	
Plat II	265.62	
Plats III and IV up to laying by, at $6 per acre	300.00	
		1,053.30
Net profit on 100 acres		676.35
Net profit per acre		6.76

It may be added that the proprietor of the plantation upon which this work was conducted had 300 acres in improved cotton (not under contract with the Division of Entomology) upon which he made 209 bales. In 1902 on the same place he had about 700 acres in native cotton, but produced only 200 bales. This bears out the observation referred to in another place that the improved varieties may be depended upon to produce at least twice as much as the native plants under similar conditions.

A VARIETY TEST.

In order to ascertain the comparative value of several of the different varieties of cotton in avoiding damage by the boll weevil, eight more or less well-known varieties were planted in plats of 5 acres each

in a typical situation in the Brazos Valley near Calvert. The land had been in cotton for many years. The year before the plants were left standing until after frost, and consequently the weevils were everywhere abundant. The soil was uniform throughout, and all plats were cultivated by the negro tenants, who gave them the same attention that would be given any cotton grown in that locality. The native cotton was the ordinary cotton of the region. It has been planted and replanted there in many instances for as long as a quarter of a century. The variety is unknown, but it evidently has some relationship to the Texas Storm Proof group. Planting took place the first week in April. The following table shows the results of this experiment:

Yield of several varieties of cotton in experimental plats near Calvert, Tex.

Variety.	Yield per acre, cotton in seed.	Variety.	Yield per acre, cotton in seed.
	Pounds.		*Pounds.*
Herndon	801	Texas Bur	456
King	672	Shine	449
Dickson	590	Native	304
Hutchinson	573	Jones Improved	286

This test was a severe one, because exceptionally unfavorable local conditions made that particular region the most seriously damaged one in Texas. The production on the plantations of the neighborhood certainly did not average more than one-seventh of a bale to the acre. But, notwithstanding the disadvantage, it will be seen that two varieties, namely, the King and the Herndon, produced about a half a bale to the acre, which, at current prices, was quite profitable; while the native cotton produced one-fifth of a bale per acre, a yield from which, with the labor conditions of that locality, there could scarcely be any appreciable profit. The only variety which proved to be less productive than the native was the Jones Improved, in which the improvers have sacrificed earliness for largeness of boll, productiveness, and strength of stalk. The variety would certainly be valuable if it were allowed to mature, but its lateness will always make it very undesirable in regions infested by the boll weevil.

EXPERIMENT SHOWING DAMAGE RESULTING FROM FAVORABLE HIBERNATING QUARTERS.

This experiment was performed in Travis County, Tex. The accompanying diagram (fig. 4) will make the details clear. Plats 2 and 3 were in sorghum the preceding year. The stubble was not removed until shortly before planting time. Plats 1 and 2 were in cotton the year before, and the plants were left standing until December. The soil was uniform throughout, and all four plots were cultivated exactly

alike. The increased number of weevils in the plots on the stubble land was evident early in the season. On August 5, when the plants were beginning to put on squares abundantly, it was found that 43 per cent of the squares were infested in plats 2 and 3, while 36 per cent

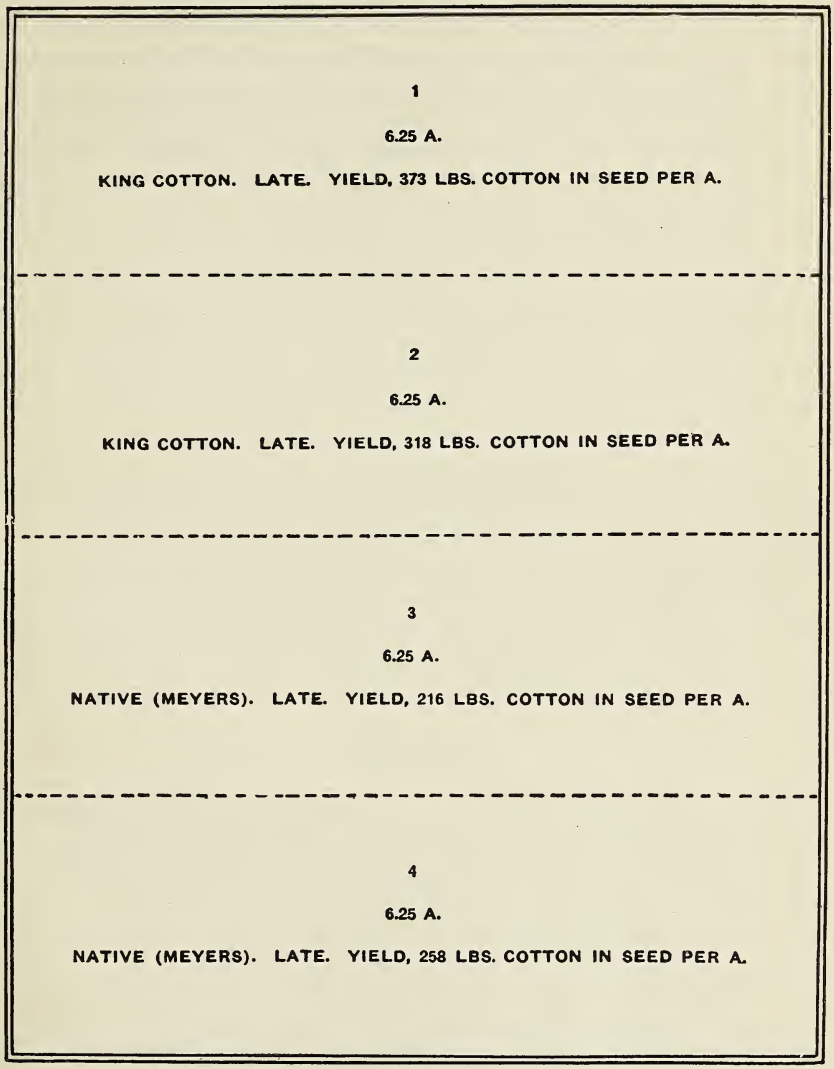

FIG. 4.—Experiment showing damage resulting from favorable hibernating quarters.

in plat 1 and 33 per cent in plat 4 were infested. This greater damage in the case of the cotton planted on the sorghum stubble continued uniformly until late in the season, when a natural overflow of weevils from plats 2 and 3 caused the adjoining plats to be affected to about the same extent. As will be seen from the diagram, the fact

that the weevils did not reach the plats removed from the sorghum until late caused the production in the case of both King and native cotton to be increased at about the same ratio.

This experiment demonstrates to what extent weevil damage may be expected when cotton is planted where conditions have been favorable for hibernation. It explains the fact of greater damage in certain localities that many planters have observed. The obvious conclusion is that cotton should not be planted upon land which was in sorghum the preceding year. In case it is impossible or inexpedient to avoid such planting, the best that can be done would be to plow under the stubble as deeply as possible early in the fall. It should be mentioned that sorghum stubble is only an example of many situations favorable for the hibernation of the weevil. Any portion of any crop or weeds or grass left upon the ground not only serves in itself to protect the pest during the winter, but in addition catches débris carried by the winds, and thus causes the protection to be all the more complete. Clean farming, by which is meant the killing of all weeds by thorough cultivation, and the removal of all portions of the crop from the land by burning or plowing under as soon as possible after the time of harvesting, is nearly as important in the case of a sorghum or corn field that is to be put in cotton the following season, provided there are cotton fields adjoining, as it will be subsequently in the cotton field.

The foregoing experiment incidentally shows a rather striking superiority of an early variety over a late one, even under the most unfavorable conditions of lateness of planting and abundance of weevils. The two fields of the early variety together yielded nearly 35 per cent more cotton than the two fields of the native variety together.

PROSPECTS.

The steady extension of the territory affected by the weevil from year to year, until the northern boundary is far north of the center of cotton production in the United States, has convinced all observers that it will eventually be distributed all over the cotton belt. In ten years it has gradually advanced a distance of about 500 miles, and will undoubtedly invade new territory at about the same rate. It is not at all likely that legal restrictions of any kind would prevent or materially hinder this spread. The slowness of the progress up to the present time indicates that the principal means of spreading are only natural ones, like the winds and a simple overflow from field to field, and that the artificial agencies like transportation in seed or in other commodities are comparatively unimportant; otherwise, with the extensive shipping from Texas, instead of being confined to that State as at present, the pest would now be found in many localities throughout the South. Legal restrictions could only be directed against these

artificial means of distribution and would be expensive and difficult to enforce. The benefits could be no more than temporary, and might be more than counterbalanced by the damage resulting from interference with shipping. It seems that the best that planters in any uninfested locality can do to prevent the incoming of the weevils would be only palliative, and would consist in avoiding the procurement of seed from localities that are known to be infested, and also in avoiding as much as possible the hauling of hulls and other seed products in which the weevils are more or less likely to be found from the mills to the vicinity of cotton fields.

Unfortunately, it must be confessed that during the time the weevil has been in Texas it has displayed no tendency toward dying out. In south Texas it is practically as troublesome now, except in so far as it is affected by changes in managing the crop, as it was in 1895; and in Mexico, where it has existed for a much longer period, it is apparently as plentiful as ever. The investigators of the Division of Entomology have made an especially careful study of all the features of the life history of the pest that would throw any light upon the question of whether it will, like many other injurious species, die down and gradually become a much less important enemy to the plant than now. In this work attention has been paid to parasites and diseases, and an exhaustive study has been made of temperature conditions in connection with several months' work on the hibernation of the pest, at Victoria, by Mr. Schwarz. Likewise the accounts of related species both in this country and in Europe have been used for comparison. It is true that it is a well-known general observation that many species of insects, upon reaching a new region, are stimulated by an abundance of food and the absence of the conditions that might have held them measureably in check elsewhere to a more rapid multiplication than normal. In order to avoid errors from this source as much as possible the laboratory of the investigation was located in the cotton-producing portion of the southern part of Texas, where the infestation has been longest. Nevertheless, all the observations and experiments have failed to reveal any factors that show any indication of causing the pest to become much less destructive than now. After ten years, during which it has maintained practically constant numbers, there seems but little risk in the statement that the pest will probably always be as destructive in a series of years as it has been in Texas since 1894. However, planters will undoubtedly gradually adopt new methods in raising cotton, so that the damage in any given locality will not be as noticeable as it was in the beginning, and climatic conditions will undoubtedly cause temporary diminution of the numbers of the pest in certain localities. In Texas these conditions have given rise almost every year to the supposition on the part of some planters

that the insects have died out, while the experience of the following season has invariably destroyed their hopes. In general, wet winters and dry-growing seasons are unfavorable for the weevil. When a series of years involving such conditions is followed by a season of less than normal rainfall, the weevil will be temporarily a comparatively unimportant factor, although its presence will undoubtedly always prevent the maturity of a fall crop. The most disastrous seasons will be those like the past season (1903), in which the rainfall is excessive and the planting time unavoidably late.

WILL THE WEEVIL REACH OTHER COTTON-PRODUCING COUNTRIES?

The fact that several European governments are sending agents to this country to procure seed to be used in experiments in producing the staple in their colonies lends some interest to speculation as to the probability that the weevil may soon be carried to remote portions of the globe. Although the insect does not, except accidentally, hibernate within the hull of the seed, every seed house attached to a gin in the infested territory harbors many that are picked accidentally and brought in from the fields in the seed cotton. In case the seed happens to be sacked or even shipped in bulk there is nothing whatever to prevent the weevils from being carried long distances on shipboard. When thus transported the indications are that they would be able to adapt themselves successfully to climatic conditions anywhere that cotton may be grown, unless possibly in a region of great elevation, like that of the Laguna district in Mexico. Although the writer is informed that the agents engaged in obtaining American seed are carefully avoiding the infested portions of Texas, in view of the foregoing and of the fact that the pest is spreading rapidly, the probability that it may eventually be carried to West Africa or elsewhere is not at all remote. This could be easily avoided by fumigation of the seed or by leaving it sacked in storage rooms isolated from new cotton for a year previous to shipment.

DESCRIPTION OF WEEVIL.

Every intelligent planter in the weevil-infested area is able to determine the presence of the pest by its appearance and the evidence of its work, but planters who have never seen it are often in doubt as to whether some insect damaging the crop is the boll weevil or not, as well as to whether flaring and falling of the fruit is caused by some unseen insect pest or by climatic conditions. For the benefit of Texas planters outside of the weevil territory at present, as well as planters in other States where the pests are more or less likely to be found at any time, the following description of the insect and its work are

given. It is believed that this will enable any planter to determine whether or not the pest is at work in his fields, and to take the necessary steps to fight it at the earliest possible moment.

The adult weevil averages about one-quarter of an inch in length,

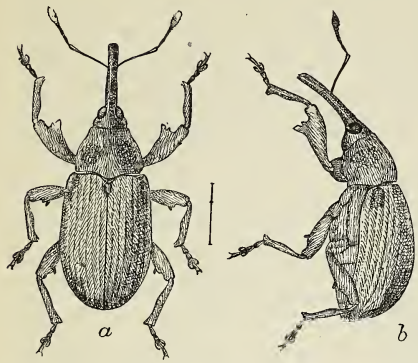

FIG. 5.—Cotton boll weevil: *a*, beetle, from above; *b*, same from side—about five times natural size (original).

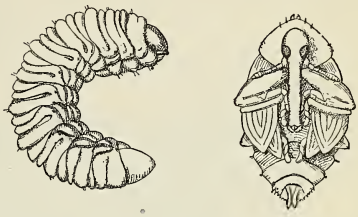

FIG. 6.—Cotton boll weevil: larva at left, pupa at right—about five times natural size (original).

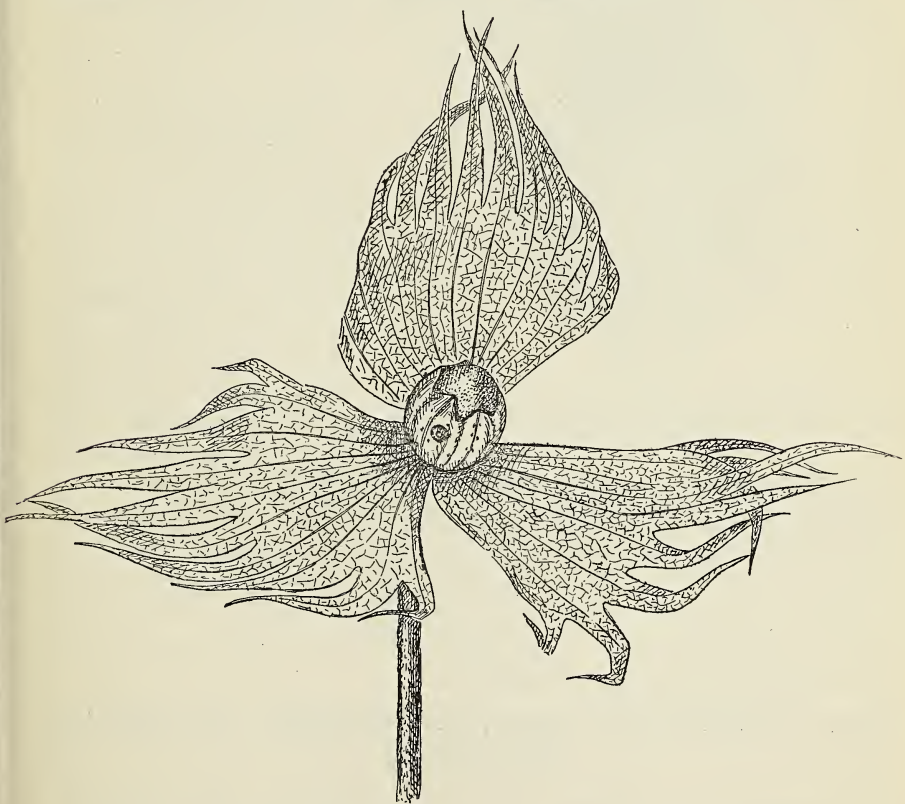

FIG. 7.—Cotton square showing egg puncture of boll weevil—natural size (original).

and has a beak about one-half the length of the body. It is of grayish or reddish-brown color. Its general appearance will be understood

from fig. 5. The insect exists in four stages—egg, larva, pupa, and adult (fig. 6). All the stages except the last occur only inside of the cotton square or boll. The egg is deposited by the female weevil in a cavity formed by eating into the fruit of the plant (fig. 7). It hatches, under normal conditions, in two or three days, and the grub immediately begins to feed. In from seven to twelve days the larva or grub passes into the pupal or quiet stage, corresponding to the cocoon of the silkworm. This stage lasts from three to five days. Then the adult weevil issues, and in about seven days begins the production of another generation. Climatic conditions cause considerable variation, but on an average it requires from two to three weeks for a weevil to develop from the egg to the adult.

FIG. 8—Cotton square showing boll weevil larva in position—natural size (original).

The plainest indication of the presence of the weevil in a cotton field is in the flaring (fig. 8) and falling of the squares or forms, which take place, in general, within a day or two after the egg is deposited. However, as all planters are aware, heavy rains after drought, as well as some other climatic conditions, have the same effect upon the plants. If the planter should observe an unusual shedding of the fruit, he may easily determine the cause by gathering a few of the fallen squares. If upon cutting open these squares he finds a small, whitish, curved grub, there is but little doubt that the cause of the trouble is the boll weevil. The specimen should then be sent to an entomologist for final determination.

LEGAL RESTRICTIONS CONCERNING SHIPMENT OF INFESTED COTTON SEED.

A realization of the damage likely to be caused to a most important crop by the introduction of the weevil into several States has led to the legal restrictions that are noted below. It will be seen that four

States, namely, Alabama, Georgia, North Carolina, and Louisiana, have very definite legislation on this matter, while one other, Mississippi, is about to enact similar regulations. For the purpose of delaying the progress of the boll weevil as well as for application to other injurious insects and plant diseases that may appear, it is recommended that a law similar to that in force in Georgia and Louisiana be enacted in all other Southern States.

ALABAMA.

AN ACT to prevent and prohibit the importation of seed from cotton affected with the Texas boll weevil.

SECTION 1. *Be it enacted by the legislature of Alabama,* That no person shall import or bring into the State of Alabama any seed from any cotton affected with what is known as the Texas boll weevil, nor the seed from any cotton from any place where the cotton has been affected with said boll weevil.

SECTION 2. Any person who violates the provisions of section 1 of this act shall be guilty of a misdemeanor, and on conviction shall be fined not less than ten dollars ($10) and not more than five hundred dollars ($500).

(H. 877, No. 559, approved Oct. 6, 1903.)

GEORGIA.

The crop-pest law of Georgia creates a board of entomology, and gives this board the power to enact and enforce such regulations as it may deem necessary to prevent the introduction or dissemination of seriously injurious crop pests or diseases. In accordance with this law the board has from time to time revised its regulations and has adopted new ones as circumstances have warranted. Under date of August 28, 1903, the State board of entomology adopted the following regulation with reference to the cotton boll weevil:

It shall be unlawful for any firm, person, or corporation to bring into the State of Georgia, or to have in possession for any purpose, any living Mexican boll weevil or any cotton bolls, squares, plants, or seed containing the adult, pupal, larval, or egg stage of the Mexican boll weevil.

No cotton seed grown in the States of Texas or Louisiana or consigned from points in those States shall be shipped into the State of Georgia without being accompanied by a certificate signed by a duly authorized State or Government entomologist stating that said cotton seed has been fumigated in such manner as to kill any boll weevils, larva, or pupa which may be contained therein.

NORTH CAROLINA.

The State of North Carolina has taken no legal measures to prevent the introduction of the boll weevil beyond the enactment of the crop-pest law which was passed in 1897. This law gives the crop-pest commission specific powers which may be applied to the boll weevil as they have been applied to various other insects. Following are the essential points in the law: The commission is given authority to make regulations for its own government, as well as such as may be requisite

for carrying out the provisions of the act which is entitled "An act to prevent the introduction and dissemination of dangerous insect, fungous, and weed pests of crops." The commission may also adopt regulations not inconsistent with the laws and constitution of North Carolina and the United States for preventing the introduction of injurious crop pests from without the State, and for governing common carriers in transporting plants liable to harbor such pests to and from the State, and such regulations shall have the force of law. When the crop commission has reason to suspect that any pest listed by them as injurious exists in any county of the State, they are required to cause such suspicion to be verified by a person competent to determine the specific identity of the pest, and if such suspicion proves founded upon fact, is further required to appoint for a designated time and duty a competent person for their agent to inspect such infested premises and to take such measures for treating them as the commission may direct. Anyone who shall seek to prevent inspection or who shall otherwise interfere with the operations of the commission in the performance of its duties shall upon conviction be fined not less than $5 nor more than $50 for each offense, or may be imprisoned for not less than ten nor more that thirty days.

(Chapter 264, Laws of 1897, ratified March 5, 1897.)

MISSISSIPPI.

At present the State of Mississippi has enacted no special legislation against the boll weevil; however, the legislature is now (January, 1904) in session and some provision similar to those in force in other States will probably be made.

LOUISIANA.

A recent special session of the legislature created a crop-pest commission that is charged with the formulation of such regulations as seem to be necessary in order to prevent a further advance of the boll weevil in the cotton fields. This commission, consisting of the State commissioner of agriculture, the director of the experiment station, the State entomologist, and two practical farmers, is now (January) in session. It is empowered to deal with all fruit and crop pests and is authorized to prohibit the shipment into the State of any cotton seed or other farm product from any region known to be infested by the weevil, except under such rules and regulations as it may promulgate. The act prohibits bringing into the State or having in possession any live weevils, under a penalty of not less than $25 nor more than $100, or imprisonment for not less than ten days or more than six months. Similar penalties apply to violations of any rules the commission may establish.

(Act No. 6, approved December 15, 1903.)

WARNING.

As a result of the recommendations of the Division of Entomology in regard to planting the seed of early varieties of cotton, which have been emphasized repeatedly by the executive committee of the Dallas Boll Weevil Convention and through other channels, there has been a sudden and enormous demand for special seed. In fact the demand in many cases has exceeded the supply. The result has been to inflate the prices of the seed of certain varieties and, more unfortunately, to cause unscrupulous persons to attempt to dispose of common seed from various localities as that of the early maturing varieties. This matter has gained such headway that it has been considered necessary that this warning be issued to Texas cotton planters. The cotton seed known as "run of the gin seed" from the eastern portion of the belt, though likely to be somewhat better than native seed on account of its more northern origin, is nevertheless almost certain to prove a disappointment to the purchaser. In comparison with the seed of select varieties it is not worth the price that is being charged for it. Planters who have occasion to obtain cotton seed should procure it in all cases where practicable through reputable seed houses, and in no case should seed be accepted without a guaranty as to its character. It is known of course that such a guaranty would be a recourse of doubtful legal value, but the moral effect of it at least would doubtless serve to protect the planter against fraud.